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ORIGINAL PAPER

Effect of growing media on seed germination and vigor in biofuel tree species

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Abstract: To evaluate laboratory germination media, seed germination rates and methodology for both *Jatropha curcas* and *Pongamia pinnata* were counted in different germination medium, such as river sand, quartz sand and vermiculite. The seeds of both species were sown at 2-cm depth of river sand, quartz sand and vermiculite. We evaluated methodologies of seeds of *J. curcas* and *P. pinnata* by ISTA (International Seed Testing Association). The results showed that river sand is the best medium for tree seeds planted at 2-cm depth of River sand. Vermiculite was second best. On paper media, there were many abnormal seedlings and this media were unsuitable for germination of the larger seeds.

Keywords: *Jatropha curcas*, *Pongamia pinnata*, germination media, normal seedlings

Introduction

Jatropha (*Jatropha curcas*) and Pungam (*Pongamia pinnata*) are trees in backyards of households in India based on their multipurpose utility. These species are becoming more important in plantation forestry because of their utility as crops for production of fossil fuel, and they are typically propagated from seeds (Daniel and Hegde 2007). Among many seed quality characters, germination is most important. It should be evaluated in appropriate media to give accurate and reproducible results. Germination of seed in a laboratory test is essential structures, which indicates whether or not it is able to develop further into a satisfactory plant under favorable conditions in soil (ISTA 2007). Laboratory environmental conditions (moisture, temperature, aeration and light) must not only facilitate seed germination but also be favorable for the development of seedlings. Differences in characteristics of germination media such as river sand, paper, and vermiculite influence germination testing because seeds have species-specific germination requirements for moisture and oxygen. Generally, sand is most suitable medium for germination of large seeds and paper medium for small seeds (Bahar 2008). Our study objective was to evaluate laboratory germination media and methodologies for seeds of *J.curcas* and *P. pinnata*.

Materials and methods

Seed sources

The study was carried out at the Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India during 2009 and 2010. Seeds of *J. curcas* and *P. pinnata* were collected from two separate sites in Tamil Nadu, viz., *J. curcas* from Mettupalayam (11.3000° N, 76.9500° E), and *P. pinnata* from Cuddalore (11.75° N, 79.75° E).

Germination testing

Seeds of *J. curcas* and *P. pinnata* were germinated in a temperature-controlled cabinet (at 30°C). Six types of germination media were used, viz. top of paper (TP), and rolled paper towel (RT), river sand (SS), top of sand (TS) (ISTA 1976), detoxified white quartz sand (QS), and vermiculite (VT). In river sand, quartz sand and vermiculite, seeds of both species were sown at 2-cm depth. In the top-of-sand method, seeds were pressed into the

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surface of the sand. For each germination medium, 100 seeds were evaluated in four replicates.

Data recording

Seeds germination rate was evaluated at 16 and 25 days after sowing for *J. curcas* and *P. pinnata*, respectively. The methodology of seed germination was categorized as normal, abnormal, hard or dead seeds (ISTA 1999). We randomly selected ten normal seedlings to measure root and shoot lengths and fresh weight and dry weight in grams (Gupta 1993). Rate of germination was calculated based on the following formula of Maguire (1962):

$$S = \frac{x_1}{Y_2} + \ldots\ldots \frac{x_2 - x_2}{Y_2} \ldots\ldots + \frac{x_n - x_n}{Y_n} + \ldots\ldots \quad (1)$$

where, S is rate of germination, X_1, X_2 and X_n are number of seeds germinated on first, second and nth day, respectively and Y_1, Y_2 and Y_n are number of days from sowing to first, second and nth day, respectively.

Vigor index values were computed (Abdul Baki and Anderson 1973) adopting the following formulae:

$$V = G(\%) \times T \quad (2)$$

where, V is Vigour index; G is Germination (%); T is Total seedling length (cm).

Statistical analysis

Data were analyzed using analysis of variance (Panse and Sukhathme 1985). Significance level was set at 5%.

Results and discussion

Seed germination rate varied significantly by germination medium for both *J. curcas* and *P. pinnata* (Table 1 and 2). Seed germination began on the 5th and 16th days after sowing on quartz sand and on the 5th and 17th days after sowing on river sand for *J. curcas* and *P. pinnata*, respectively. The rate of seed germination was highest on vermiculite for *J. curcas* and quartz sand for *P. pinnata*. Germination rate was slowest on paper media for both species. Seed germination on top of paper was delayed by five and four days, compared to quartz and sand germination media for *J. curcas* and *P. pinnata*, respectively. The highest germination percentages were recorded in river sand for *J. curcas* (82%) and *P. pinnata* (88%), while vermiculite yielded slightly lower germination percentages (Figs. 1 and 2). Zhe et al. (2009) reported that seeds germinated in quartz sand were seemed to grow faster but in a few days after germination, seedlings died. We recorded no seedling mortality in quartz sand but seed germination was faster in river sand than in quartz sand. Seed germination rate of *P. pinnata* on sand media (2-cm depth) was higher by 6%, compared with vermiculite.

Table 1: Effect of media on germination behaviour of *Jatropha curcas* seeds

Media		Germination rate (%)*	Abnormal seedlings (%)*	Hard seed (%)	Dead seeds (%)	Shoot length (cm)	Root length (cm)	Fresh weight (g)	Dry weight (g)	Vigour index
Germination paper	RT	38 (38.2)	20 (26.5)	Nil	42	20.0	14.5	40.5	4.9	1321
River sand	TP	25 (29.9)	25 (29.7)		50	5.5	4.0	30.6	4.4	238
	TS	12 (19.9)	3 (8.6)		85	18.1	7.5	34.8	3.7	302
SS		82 (64.7)	2 (4.4)		16	22.9	8.2	49.2	4.5	2544
VT		50 (45.0)	10 (18.0)		40	20.6	5.4	43.5	3.9	1300
QS		67 (54.7)	2 (4.4)		31	21.4	8.4	50.3	6.1	2043
Mean		46 (42.1)	10 (15.3)		44	18.3	8.0	41.4	4.6	1291
SEd		2.0	5.2		2.52	1.7	0.8	2.3	0.5	136.8
CD (P=0.05)		4.4	11.4		5.5	3.7	1.7	4.9	1.0	298.1

Notes: RT is Roll towel; TP is Top of the paper; TS is top of the sand; SS is Sand at 2-cm depth; VT is vermiculite at 2-cm depth and QS is Quartz sand at 2-cm depth. *The germination value will be in percentage, so the percentage data will not be amenable for parametric analysis. So we used Arc Sine transformation value. Nil is there is no hard seeds found. Hard seeds are viable seeds but it is not germinate in particular period of test.

Frequency of normal seedlings was higher in sand (SS and QS) and vermiculite than in other media. Moreover, abnormal seedlings with the decayed and deformed seedlings and dead seeds were higher in paper media. We conclude that paper medium is not a suitable medium for germination of *J. curcas* and *P. pinnata* seeds. Based on easy availability and economic utility for *J. curcas* and *P. pinnata*, the river sand could be used as the testing media, but in that too, in sand media (SS) method should be adopted for obtaining reproducible results in the germination test. It was followed by quartz sand (QS) and vermiculite (VT) germination medium.

Table 2: Effect of media on germination behaviour of *Pongamia pinnata* seeds

Media		Germination rate (%)*	Abnormal seedlings (%)*	Hard seed (%)	Dead seeds (%)	Shoot length (cm)	Root length (cm)	Fresh weight (g)	Dry weight (g)	Vigour index
Germination paper	RT	25 (29.9)	15 (22.6)	Nil	60	14.7	16.4	43.6	10.9	623
River sand	TP	20 (26.5)	17 (24.1)		63	5.4	3.7	19.9	12.9	229
	TS	0 (0.1)	0 (0.1)		100	0.0	0.0	0.0	0.0	0.0
SS		88 (70.1)	8 (13.8)		4	28.1	14.6	42.9	11.6	3768
VT		60 (50.8)	5 (10.5)		35	23.3	14.1	39.5	11.4	2248
QS		83 (66.1)	5 (12.9)		12	28.8	19.9	45.5	12.4	4065
Mean		46 (40.6)	8 (14.0)		48	16.7	11.5	31.9	9.9	1822
SEd		2.6	5.3		2.2	1.3	1.2	1.2	0.5	166.4
CD (P=0.05)		5.7	11.6		4.8	2.9	2.5	2.6	1.1	362.6

Notes: RT is Roll towel; TP is Top of the paper; TS is top of the sand; SS is Sand at 2 cm depth; VT is vermiculite at 2 cm depth and QS is Quartz sand at 2cm depth. *The germination value will be in percentage, so the percentage data will not be amenable for parametric analysis. So we used Arc Sine transformation value. Nil denotes that there is no hard seed found. Hard seeds are viable seeds but it is not germinated in particular period of test.

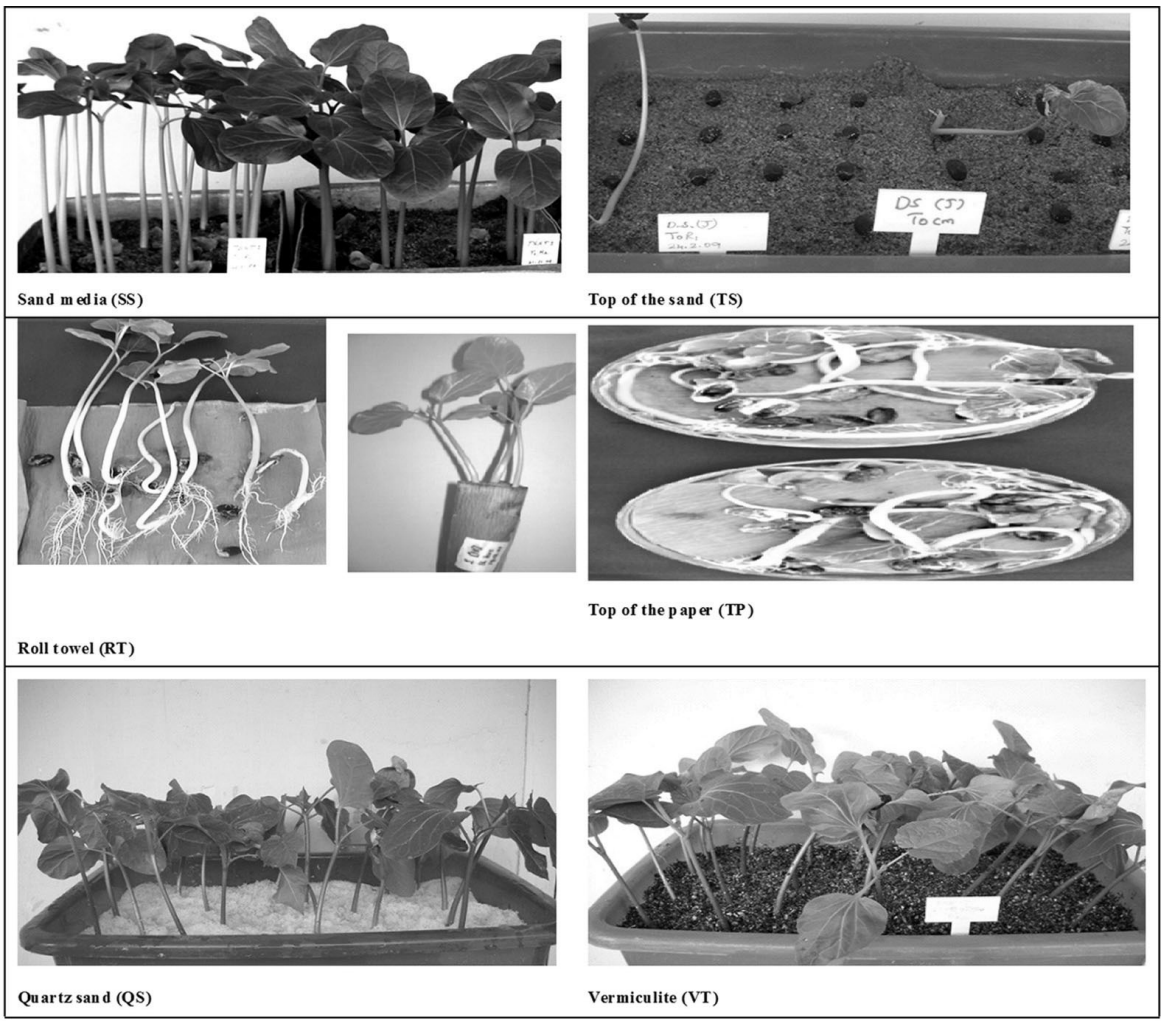

Fig. 1: Evaluation of *Jatropha curcas* seed germination in different media and methods

Frequency of normal seedlings was higher in sand (SS and QS) and vermiculite than in other media. Moreover, abnormal seedlings with the decayed and deformed seedlings and dead seeds were higher in paper media. We conclude that paper medium is not a suitable medium for germination of *J. curcas* and *P. pinnata* seeds. Based on easy availability and economic utility for *J. curcas* and *P. pinnata*, the river sand could be used as the testing media, but in that too, in sand media (SS) method should be

adopted for obtaining reproducible results in the germination test. It was followed by quartz sand (QS) and vermiculite (VT) germination medium.

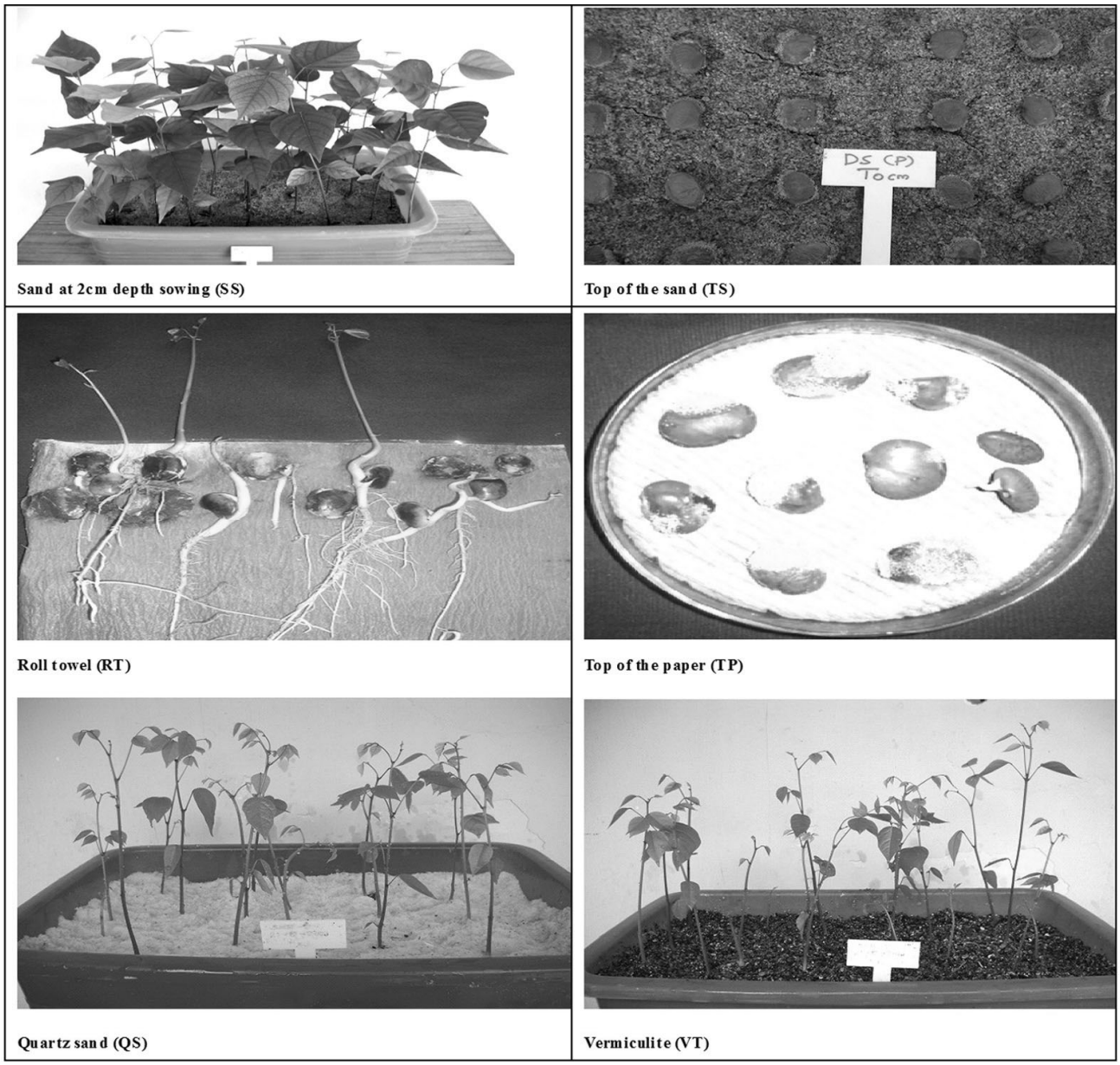

Fig. 2: Evaluation of *Pongamia pinnata* seed germination in different media and methods

Bahar (2008) reported that the choice of germination medium depends on the species being tested. Minute seeds are best germinated on top of paper while large seeds are best germinated in sand or on paper towel. Paper towel is more commonly used for germination of medium-sized seed because. Large seeds can also be rolled in paper towel when seed quantities are small but it is an inconvenient method to test a large number of seeds at one time. Sand is not suitable for very small seeds but is widely used for large seeds especially for tree seeds that require longer periods of time for germination. Sand can be sterilized easily and fungal development on sterilized sand is easier to be controlled. Sand also provides good contact between the seed and moisture because seeds can be pressed into the medium. Sand has often proven to be the best medium for germination of forest tree seeds (Bahar 2010; Hassanein 2010; Bahar and Singh 2007; Sagta and Nautiyal 2001).

Our findings are supported by the research of Egharevba et al. (2005, 1987a, b; Vilela and Ravette 2001; Docker and Hubble 2008; Thapliyal and Rawat 1991). Each of these authors recommends use of sand and in-sand planting for production of highest percentages of normal seedlings from irrespective the source seeds.

Conclusions

River sand is the best medium for evaluating the germination of normal seedlings in *Jatropha curcas* and *Pongamia pinnata*. Paper media (RT and TP) produced many abnormal seedlings, showing that these media are unsuitable for larger seeds.

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